Appendix B

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Eastern towhee

Process for Establishing Refuge Focal Species and Priority Habitats for Great Bay National Wildlife Refuge

- Introduction
- Process Overview
- Literature Citations

Introduction

Biological goals and objectives serve as the foundation for refuge Comprehensive Conservation Plans (CCPs) and Habitat Management Plans (HMPs). These goals and objectives guide all management decisions regarding species and habitats. Prior to drafting biological goals and objectives, each refuge first identifies the species of conservation concern and priority habitats that will be the focus of its management. This appendix details the process the Great Bay National Wildlife Refuge (Great Bay Refuge, refuge) CCP planning team (we) used to identify these priority resources of concern, and ultimately, the refuge focal species and the habitat management priorities to benefit these resources.

Process Overview

We consulted many sources to determine the priority resources of concern for the refuge, including legal mandates, U.S. Fish and Wildlife Service (Service) policies, the refuge's establishing purposes, and a variety of national, regional, State, and local conservation plans. We also considered the refuge's geographic location, local site capabilities, species' relative abundance and distribution, and respective species status in national and regional conservation plans. Additionally, we determined the most important and effective ecological contribution the refuge could make to the Great Bay Estuary, the State of New Hampshire, the Gulf of Maine Ecosystem, and the National Wildlife Refuge System (Refuge System).

Using the factors outlined above, we created a list of priority species and habitats. After grouping the habitats into broad categories, we sorted priority species by habitat type. For each of these broad habitat category types, we also selected a focal species to guide habitat management and for monitoring purposes.

1) Collect Information and Data

1.1) Refuge's Establishing Purposes, Legal Mandates, and U.S. Fish and Wildlife Service Policies

The process for selecting resources of concern was guided by the refuge's establishing purposes, legal mandates for the Refuge System, and Service policies.

Establishing Purposes:

The purposes of Great Bay Refuge were defined in the land transfer that established the refuge in 1992, as follows:

- To encourage the natural diversity of plant, fish, and wildlife species within the refuge, and to provide for their conservation and management.
- To protect species listed as endangered or threatened or identified as candidates pursuant to the Endangered Species Act of 1973.
- To preserve and enhance the water quality of aquatic habitat within the refuge.
- To fulfill the international treaty obligations of the United States relating to fish and wildlife.

Legal Mandates:

Chapter 1 of the CCP describes the legal mandates guiding the management of the Refuge System. The following legal mandates relate to the identification of priority resources of concern on a refuge.

1. The Emergency Wetlands Resources Act of 1986 (16 U.S.C. § 3901 (b))
   "…for the conservation of the wetlands of the Nation in order to maintain the public benefits they provide and to help fulfill international obligations contained in various migratory bird treaties and conventions."

2. The Migratory Bird Conservation Act (16 U.S.C. § 715d)
   "…for use as an inviolate sanctuary, or for any other management purpose, for migratory birds."

3. The Endangered Species Act of 1973, as amended (16 U.S.C. § 1531-154)
   "The Secretary of the Interior….is designated as the Management Authority and the Scientific Authority for the purposes of the Convention and the respective functions of each Authority shall be carried out through the United States Fish and Wildlife Service."

The Act also requires that
"all Federal departments and agencies shall seek to conserve endangered species and threatened species and shall utilize their authorities in furtherance of the purposes of this Act."

4. Fish and Wildlife Act of 1956 (16 U.S.C. § 742 f(a)(4))
   "…for the development, advancement, management, conservation, and protection of fish and wildlife resources..."

5. Refuge Recreation Act of 1962 (16 U.S.C. § 460k—460k-4)
   "…(2) the protection of natural resources, (3) the conservation of endangered species and threatened species…"

6. Refuge System Improvement Act of 1997 (Section 4(a)(3)
   "(A) each refuge shall be managed to fulfill the Mission of the System, as well as the specific purposes for which that refuge was established..."

The Improvement Act further states that
"In administering the System, the Secretary shall...ensure that the biological integrity, diversity, and environmental health of the System are maintained for the benefit of present and future generations of Americans..."

Various legislative and administrative acts also entrust the conservation and protection of certain species and habitats to the Service, called "Federal trust resources." These include migratory birds, interjurisdictional fish, federally listed threatened and endangered species, wetlands, and certain marine mammals.

Service Policies:

Policy on Biological Integrity, Diversity, and Environmental Health (601 FW 3.3)

This policy provides guidance on maintaining or restoring the biological integrity, diversity, and environmental health of the Refuge System (601 FW 3), including the protection of a broad spectrum of fish, wildlife, and habitat resources in the refuge ecosystems. The policy explains the relationships among refuge purposes, the Refuge System mission, and maintaining biological integrity, diversity, and environmental health as follows:

> *"…each refuge will be managed to fulfill refuge purpose(s) as well as to help fulfill the [Refuge] System mission, and we will accomplish these purpose(s) and our mission by ensuring that the biological integrity, diversity, and environmental health of each refuge are maintained, and where appropriate, restored." (601 FW 3.7B)*

The policy advocates for an integrated and holistic approach to maintaining and restoring biological integrity, diversity, and environmental health. The policy directs refuges to evaluate biological integrity, diversity, and environmental health at several scales:

- The local scale, such as removing dams to restore historic stream flows.
- The larger landscape scale, such as supporting population and habitats that have declined or been lost at from ecosystem.
- The national or international scale.

It also highlights the dynamic nature of historical natural processes, and emphasizes managing within a natural range of variability to allow species, genetic strains, and natural communities to evolve with

changing conditions. According to the policy, the highest measure of biological integrity, diversity, and environmental health is conserving intact, self-sustaining habitats and wildlife populations that existed during historic conditions.

The policy also provides the following guidance on how to implement it:

1. Identify the refuge purposes, legislative responsibilities, refuge role within the ecosystem, and Refuge System mission.

2. Assess the current status of biological integrity, diversity, and environmental health through baseline vegetation and population surveys, and any other necessary environmental studies.

3. Assess historic conditions and compare them to current conditions. This will provide a benchmark of comparison for the relative intactness of ecosystems' functions and processes. This assessment should include the opportunities and limitations to maintaining and restoring biological integrity, diversity, and environmental health.

4. Consider the refuge's importance to refuge, ecosystem, national, and international landscape scales of biological integrity, diversity, and environmental health. Also, identify the refuge's roles and responsibilities within the Regional and Refuge System administrative levels.

5. Consider the relationships among refuge purposes and biological integrity, diversity, and environmental health, and resolve conflicts among them.

6. Through the CCP process, interim management planning, or compatibility reviews, determine the appropriate management direction to maintain and, where appropriate, restore, biological integrity, diversity, and environmental health, while achieving refuge purpose(s).

7. Evaluate the effectiveness of our management by comparing results to desired outcomes. If the results of our management strategies are unsatisfactory, assess the causes of failure and adapt our strategies accordingly.

1.2) Matrix of *Potential* Resources of Concern Based on National, Regional, State, and Local Conservation Plans

We generated an overall list of species and plant communities of conservation concern that were either known, or suspected, to occur on Great Bay Refuge using national, regional, State, and local conservation plans (appendix A, table A.1). The following is a complete listing of the sources we used to compile the lists of resources of concern:

- Bird Conservation Region (BCR) 30 Plan–New England/Mid-Atlantic Coast.
- Partners in Flight (PIF) Physiographic Area 9 (Southern New England) Plan.
- North American Waterfowl Management Plan.
- U.S. Shorebird Conservation Plan.
- North American Waterbird Conservation Plan.
- U.S. Fish and Wildlife Service Birds of Conservation Concern–List for BCR 30.
- Federal List of Threatened and Endangered Species.
- New Hampshire State Comprehensive Wildlife Conservation Plan.
- New Hampshire Natural Heritage Bureau (NHB)–State List of Threatened and Endangered Species.
- Natural Communities of New Hampshire.
- New Hampshire Natural Heritage Inventory.
- Piscataqua Region Comprehensive Conservation and Management Plan (2010).
- Northeast States Nongame Technical Committee List of Species of Special Concern.

1.3) Identify Elements of Biological Integrity, Diversity, and Environmental Health

To identify the elements of biological integrity, diversity, and environmental health for Great Bay Refuge, we reviewed the historical conditions, site capability, current regional landscape conditions, and biological diversity for the refuge. The major sources we consulted included the following:

- Soils Map–U.S. Department of Agriculture Natural Resources Conservation Service Soil Types National Ecological Land Units Map.
- Kuchler's Potential Natural Vegetation Map.
- Current Vegetation Map for Great Bay Refuge–National Vegetation Classification System.
- Historical and Current Wetlands Inventory Map.
- Historical topographic and hydrological maps.
- Historical aerial photography.
- Record of land management under Pease Airport (documented habitat alterations).
- NHB Natural Communities distribution maps.
- New Hampshire State Comprehensive Wildlife Conservation Plan.
- Consultation with The Nature Conservancy.
- Consultation of NHB natural community expert.
- Targeted field investigations (e.g., tree coring of various pine groves to ascertain origin and history).

We developed the following table (B.1) to help assess the biological integrity, diversity, and environmental health elements for the existing habitats at Great Bay Refuge.

Table B.1. Biological Integrity, Diversity, and Environmental Health Elements for Great Bay Refuge

Plant Community	Population/Habitat Attributes (Soils, Structure, Species Composition)	Natural Processes/Limiting Factor
Dry Appalachian oak-hickory forest	Oaks (*Quercus velutina, Q. coccinea, Q. alba, Q. prinus, Q. ruba*), hickories (*Carya ovata, C. ovalis, C. glabra*), and white pine (*Pinus strobus*) dominated canopy. Shrub layer dominated by flowering dogwood (*Cornus florida*), mountain laurel (*Kalmia latifolia*) and American hazelnut (*Corylus americana*). Oak sedge (*Carex pensylvanica*) may form extensive "lawns." High diversity of herbaceous species, including numerous State rare species: common goldenrod (*Solidago odora*), birdfoot violet (*Viola pedata*), hairy bedstraw (*Galium pilosum*), fernleaf yellow false foxglove (*Aureolaria pedicularia*), reflexed sedge (*Carex retroflexa*), peatleaf knotweed (*Polygonum tenue*), *Tephrosia virginiana*, smooth small-leaf ticktrefoil (*Desmodium marilandicum*), prostrate ticktrefoil (*Desmodium rotundifolium*). Occurs on middle and upper slopes with acidic, low-nutrient, well-drained soils.	Successional forest—May transition to beech forest without disturbance. May stay oak-hickory with climate change with northward range shift and increasing fire frequency.
Dry-mesic Appalachian oak-hickory forest	Occurs on well-drained fine sandy loam soil. Beech, paper birch, and dry-site herbs more abundant. See " Mesic Appalachian oak-hickory forest" below.	Successional forest—Need fire or logging to maintain. Transition to sugar maple/beech forests without disturbance. May stay oak-hickory with climate change with northward range shift and increasing fire frequency.

Plant Community	Population/Habitat Attributes (Soils, Structure, Species Composition)	Natural Processes/Limiting Factor
Mesic Appalachian oak-hickory forest	Mesic and dry-mesic sites dominated by oaks (*Q. rubra, Q. velutina*), hickories (*C. ovata*), white pine, and transitional hardwoods (*Betula lenta, Prunus serotina, Fraxinus americana, Betula papyrifera, Fagus grandifolia,* and *Tsuga canadensis*). Shrub (*Viburnum acerifolium, Corylus cornuta, Hamamelis virginiana, Toxicodendron radicans, Mitchella repens, Gaultheria procumbens, Lycopodium*) and herb (*Aralia nudicaulis, Maianthemum canadense*) layer sparse to moderate. Silt loam soils with high moisture capacity or at slope-bases	Successional forest—Need fire or logging to maintain. Transition to sugar maple/beech forests without disturbance. May stay oak-hickory with climate change.
Dry to wet field mosaic	The wet meadows tend to occur on poorly drained silt or sand soils with a mixture of wetland and upland grasses, forbs, and occasional shrubs. For example, little bluestem (*S. scoparium*), sedges (*Carex spp.*), goldenrods (*Solidago spp.*), ferns (*O. sensibilis, A. filix-femina*), raspberries (*Rubus spp.*), arrowleaf (*Polygonum sagittatum*) and alder (*Alnus spp.*). The drier portions of these mosaics tend to occur on well-drained fine sandy loams and loam soils. The vegetative composition is dominated mainly by forbs and common pasture grasses (e.g., *Agrostis spp., Festuca spp. Poa spp.*). Some of the forbs and woody shrubs include milkweeds (*Asclepias spp.*), meadowsweet, steeple bush (*Spirea spp.*), goldenrods (*Solidago spp.*), and *Rubus* species.	The wet meadows are likely to succeed into red maple swamps/wet forest (e.g., red maple–sensitive fern forest or red maple–elm–lady fern forest). Dry-mesic fields will most likely succeed to oak–hickory forest without active management (e.g., fire and mowing). Also, both communities need monitoring for exotics as these sites are very susceptible to invasion due to disturbance from management actions. For example, reed canarygrass is the dominant species in the wet portion of the field and leafy spurge and autumn olive is common in dry areas.
Dry shrubland mosaic	Often contain many of the same grasses and forbs of dry field communities but have a higher abundance of young trees and shrubs. Species will vary with local seed sources but tree saplings often include birch (Betula spp.), aspen (*Populus spp.*), pine (*Pinus spp.*), and cherry (*Prunus spp.*). Shrub species include sweet fern (*Comptonia peregrina*), bayberry (*Morella pensylvanica*), blueberry (*Vaccinium spp.*), and raspberries (*Rubus spp.*).	On well-drained sandy loams and loam soils with a water table well below the ground surface. Often succeeding from dry fields, these communities tend to be susceptible to invasive species like autumn olive and honeysuckle. May succeed to oak-hickory forest without management (e.g., mowing, burning).
Mesic Shrubland mosaic	Shrubs species of these communities are dogwoods (*Cornus spp.*), blueberries (*Vaccinium spp.*), raspberries (*Rubus spp.*), birches (*Betula spp.*), fruit species (*Malus spp., Pyrus spp.*), alders (*Alnus spp.*) eastern red cedar (*Juniperus virginiana*), and buckthorns (*Ramnus spp.*). The groundcover is composed of grasses (e.g., *Agrostis spp., Festuca spp. Poa spp.*) and forbs such as goldenrods (*Solidago spp.*), asters (*Aster spp.*), and vetches (*Vicia spp.*). The mesic soil conditions of these shurblands are well-drained silt loam and fine sandy loam soils. However, the silt of these soils will have greater moisture retention compared to coarser soils.	These soil conditions tend to have seasonally high water tables compared to the dry-mesic fields and are very susceptible to invasion by exotics such as, buckthorn, and honeysuckle. A high abundance of invasive species may impede regeneration of native trees, but this community will likely succeed to mesic Appalachian oak-hickory forest if left unmanaged.

Plant Community	Population/Habitat Attributes (Soils, Structure, Species Composition)	Natural Processes/Limiting Factor
Low red maple-elm/musclewood/ lady fern silt forest	Red maple (*Acer rubrum*) is the dominant tree with American elm (*Ulmus americana*), white pine (*Pinus strobus*), white ash (*Fraxinus americana*), and swamp white oak (*Quercus bicolor*) present. The understory is commonly composed of musclewood (*Carpinus caroliniana*), climbing poison-ivy (*Toxicodendren radicans*), winterberry holly (*Ilex verticillata*), and northern arrowwood (*Viburnum dentatum*), with a well-developed herb layer dominated by lady fern (*Athyrium filix-femina*). Other species include sensitive fern (*Onoclea sensibilis*), violets (*Viola spp.*), spotted touch-me-not (*Impatiens capensis*), and high bush blueberry (*Vaccinium corymbosum*).	Occurs at intermediate zones between uplands and wetlands. Established on poorly drained silt loams with seasonally high water table. However, are not regularly flooded. Great Bay site threatened by invasive species including; buckthorn, honeysuckle, multiflora rose, and barberries.
Black gum-red maple basin swamp	Dominated by black gum (*Nyssa sylvatica*) and red maple (*Acer rubrum*) as tree canopy, highbush blueberry (*Vaccinium corymbosum*) and winterberry (*Ilex verticillata*) as the primary shrub layer, and cinnamon fern (*Osmunda cinnamonea*) and sphagnum moss as the herbaceous layer. Well-developed hummocks.	Typically found in perched upland till basins, acidic, nutrient-poor, poorly drained peat or mucky soils. Dependent on precipitation (rarity ranking: S1S2-imperiled or critically imperiled in New Hampshire).
Seasonally saturated red maple swamp	Common red maple swamp associated with stream drainages. Soils are typically alluvial or shallow muck/peat over alluvial minerals. Red maple (*Acer rubrum*) is the primary tree species, with shrub layer absent or moderately dense. Clonal graminoids such as upright sedge (*Carex stricta*) and blue joint (*Calamagrostis canadensis*) are frequent dominants.	S4S5—Differ from floodplain forests by seasonal rather than temporarily flooded water regime. Low-energy environment allows for development of organic soils. Commonly successional from wet meadows to shallow emergent marshes and have either woodland or forest canopy structure (Rarity ranking: S4S5-widespread and apparently secure in New Hampshire, may be rare in parts of its range, especially at the periphery).
Red maple/ sensitive fern-tussock sedge basin/seepage	Saturated or seasonally saturated soils with diverse assemblage of herbaceous species and relatively little sphagnum moss (less than five percent). Typically occupying headwater basins, where seepage or non-channelized upland runoff is water source. Dominated by red maple, with lesser quantities of elm (*Ulmus americana)* and other hardwood. Sensitive fern (*Onoclea sensibilis*) is a good indicator. Diverse shrub layer dominated by winterberry (*Ilex verticillata*), with assembledges of northern highbush blueberry (*V. corymbosum*), southern arrowwood (*V. dentatum*), speckled alder (*Alnus incana*), and meadowsweet (*Spiraea alba*). Other dominant herbaceous layers include sedges (*Carex stricata* and *C. bromoides*). Jewelweed (*Impatiens capensis*), blueflag (*Iris versicolor*), earth loosestrife (*Lysimachia terrestris*), fringed sedge (*Carex crinita*), royal fern (*Osmunda regalis*), and bluejoint (*Calamagrostis canadensis*) may be present.	Often found with other swamp communities in larger mosaic. The largest complex at Great Bay is 65 acres in size. Circumnetral seepage swamp—Found at Pease Tradeport. (rarity ranking: S1?- critically imperiled in New Hampshire).

Plant Community	Population/Habitat Attributes (Soils, Structure, Species Composition)	Natural Processes/Limiting Factor
Speckled alder basin/seepage shrub thicket	Dominated by speckled alder (*Alnus incana*) with lower abundance of red osier dogwood (*Cornus sericea*), mountain holly (*Nemopanthus mucronatus*), mountain fly honeysuckle (*Lonicera villosa*), meadowsweet (*Spiraea alba*), steeplebush (*S. tomentosa*), possumhaw (*Viburnum nudum*), and currant (*Ribes spp.).* Herbaceous cover include sedges (*C. triperma, C. canescens, C. echinata*) and ferns (*Dryopteris cristata, D. carthusiana, Gymnocarpium dryopteris*).	Occurs in open headwater basin, in somewhat seepy subacidic fens and along small low-energy streams.
Graminoid-forb-sensitive fern seepage marsh	Sensitive fern (*O. sensibilis*) tends to be most dominant within these systems along with other indicative species composed of sedges (*C. lacustris, C. scabrata*), ferns (*O. regalis, T. palustris*), skunk cabbage (*Symplocarpus foetidus*), and saxifrage spp. (*S. pensylvanica, C. americanum*). Species in lower abundance include spotted touch-me-not (*I. capensis*), field mint (*Mentha arvensis*), and poison sumac (*Toxicodendron vernix).* Soils are shallow fibric peats or silty muck/sands with pH ranging from 5.5 to 6.3.	Associated with groundwater discharge zones with little canopy cover (e.g., upland borders of various wetlands and along stream drainages). Under certain conditions may succeed into speckled alder wooded fen.
Tall graminoid emergent marsh	Shallow emergent marsh dominated by "tall" graminoids, typically blue-joint (*Calamagrostis canadensis*), rattlesnake manna-grass (*Glyceria canadensis*), whitegrass (*Leersia virginica*) or oryzoides, reed canarygrass (*Phalaris arundinaceae*), threeway sedge (*Dulichium arundinaceum*), upright sedge (*Carex stricta*), *C. lacustris,* woolgrass (*Scirpus cyperinus*), and Canadian rush (*Juncus canadensis*). A broad diversity of herbaceous plants is often present, but not dominant. Community with high species diversity.	Seasonally flooded communities on fine mineral to organic substrates along low-energy streams or open basins. Dominant species form rhizomatous and colonial mats, and is influenced by hydrologic regime and propagule availability. May succeed to scrub-shrub or forested swamps or deepwater marshes depending on hydrology.
Open-basin cattail marsh	Contain mucky organic soils that are seasonally to semi-permanently flooded. Soils remain saturated throughout the year with water levels near or above the ground surface. Well-developed clonal stands often have a thick mat of thatch from previous year's growth. Although dominated by common cattail (*Typha latifolia*), other species present include knotweed (*Polygonum spp.*), *Bidens spp.,* and *Scirpus* species.	Found in open basins associated the backwaters of ponds, lakes, or stream drainageways. May be susceptible to common reed (*Phragmites australis*) invasion.
Short graminoid-forb emergent marsh/mudflat	Mudflats composed of short herbaceous vegetation that is seasonally flooded or intermittently exposed. Dominated by cut-grasses (*Leersia spp.)* and manna-grass (*Glyceria spp.*)	Narrow border on edge of Peverly Pond, probably dependent upon seasonal dry spells.
Red pine forest/ woodland	Occurring on sand plains and other well drained soils or pockets of cold-air drainages. Red pine (*Pinus resinosa*) is the main canopy species with a few white pines (*Pinus strobus*), oaks (*Q. rubra, Q. alba*), and shagbark hickories (*Carya ovata*). The understory contains blueberries (*Vaccinium spp.*).	Occurs on sand plains and other well-drained soils or cold-air drainage. Fire interval of 175 to 200 years. Refuge population is about150 years old, but younger stand of red pine regenerating (about 10 to 20 years old).

Plant Community	Population/Habitat Attributes (Soils, Structure, Species Composition)	Natural Processes/Limiting Factor
Pine plantations	Four separate plantations, each with different species of trees. 1. White fir (*Abies concolor*) approximately 25 years old. 2. Blue Spruce (*Picea pungens*). 3. White pine (*Pinus strobus*) approximately 25 years old. 4. White spruce (*Picea glauca*), trees approximately 30-feet tall.	Naturally reverting to oak-hickory forest; planted pines dying from disease. Monitor for invasives (e.g., common buckthorn and autumn olive).
Low salt marsh	Dominated by smooth cord-grass (*Spartina alterniflora*) with soils of organic materials atop sandy or silty materials. Pannes and pools can be found within the low salt marsh and some vascular halophytes that may occur in low-abundance include common glasswort (*Salicornia europaea*), orach (*A. hastate, A. glabriuscula*), sea blites (*Suaeda spp.*), and macroalgae (e.g., *Ascophyllum nodosum* and *Fucus spp.*).	Occurring along coastal shorelines that are protected from high-energy wave action. The Low marsh in found between the mean sea level and mean high tide resulting in daily flooding with soil water salinity levels between 18 to 30 parts per thousand (ppt).
High salt marsh	Soils are generally organic materials (greater than 50 inches) on top of sand, silt, or bedrock. Salt-meadow cord-grass (*Spartina patens*) is the dominant vegetation but other common plants include short form smooth cord-grass *(S. alterniflora*), spike-grass (*Distichlis spicata*), and salt marsh rush (*Juncus gerardii*). The greatest species richness is found along the upper landward edge of the marsh and includes seaside goldenrod (*Solidago sempervirens*) and a variety of grasses (e.g., *Panicum virgatum, Hierochloe odorata, Festuca rubra, Elytrigia repens, Elymus virginicus*). Pannes and pools occur within the high salt marsh.	Found adjacent to the low salt marsh and occurring landward of the mean high tide mark stretching to the upper reaches of spring tides. These systems are irregularly flooded (less than daily) and have soil water salinity levels between 18 to 30 ppt.
Brackish marsh	Soils are likely sulfihemist with low surface salt content. These support a variety of species that are tolerant of the brackish conditions. The most abundant species is narrow-leaved cattail (*Typha angustifolia*), but other species found in this system include rushes (*Scirpus robustus, S. pungens*), seaside goldenrod (*Solidago sempervirens*), fresh-water cordgrass (*Spartina pectinata*), broadleaf cattail (*Typha latifolia*), and halberd-leaved orach (*Atriplex hastata*).	Along upper edges of high salt marshes where fresh water runoff or groundwater discharge flows onto the marsh surface. Only flooded by salt water during spring tides and storm surges resulting in soil water salinity ranging from greater than 0.5 to less than 18 ppt.
Low/high salt marsh complex	Combination of low and high salt marsh communities (see above). However, rather than moving on a gradient from shore to upland, the high marsh is sporadically intermixed with the low marsh due to small-scale changes in surface elevation.	Elevation changes may be due to ice scouring, erosion, and/or soil/sod deposition from ice rafts.

Plant Community	Population/Habitat Attributes (Soils, Structure, Species Composition)	Natural Processes/Limiting Factor
Coastal Rocky Headland	Occurring on bedrock with thin, acidic soil along exposed rocky points in close proximity to salt spray. Dominated by stunted eastern red cedar (*Juniperus virginiana*) with lesser amounts of black oak (*Quercus velutina*) and pines (*Pinus strobes, P. resinosa*). The understory is composed of blueberries (*Vaccinium spp.*), northern bayberry (*Myrica pensylvanica*), and creeping juniper (*Juniperus communis*).	Exposed to salt spray and maritime climate. Potential risk to invasion by established European barberry.
Coastal Shoreline Strand/Swale	Sparsely vegetated (often less than 25 percent) upper intertidal region of fine to coarse soils. Covered with wrack composed of driftwood, S. alterniflora detritus, and macroalgae. Sea-rocket (*Cakile edentula*) is the dominant vegetation. Other species present include poison-ivy (*Toxicodendron radicans*) and seaside goldenrod (*Solidago sempervirens*).	Located in protected estuarine shorelines or backdune depressions that are flooded less than daily.
Intertidal Rocky Shore	Estuarine rivers, streams, or partially enclosed shoreline composed of coarse soils, rubble, and bedrock substrates. Vegetation is mainly macroalgae (*A. nodosum, F. vesiculosus*).	Flooded daily by tides but protected from strong currents and high-energy wave action.
Forest On Fill	Approximately 20-year old forest on sandy, silty fill of udorhents soil. Tree species include: trembling aspen (*Populus tremuloides*), birches (*Betula populifolia, B. papyrifera*), red maple (*Acer rubrum*), white pine (*Pinus strobus*), and white ash (*Fraxinus americana*). Understory species include blackberry (*Rubus spp.*) and dogwood (*Cornus spp.*).	Invasives (buckthorns and multi-flora rose) established in understory.

2) Identify Priority Resources of Concern

To guide the determination of which resources of concern should be a management priority, the planning team consulted the previously mentioned bird conservation plans, partner prioritization lists, the refuge's purposes, and the Service's Biological Integrity, Diversity, and Environmental Health Policy. We also used survey data for the refuge and surrounding area, and analyzed current and potential natural vegetation and desired future conditions.

As previously mentioned, the refuge needs to consider multiple geographic scales when determining its greatest contribution to species and habitat conservation. This type of analysis ensures the refuge's goals are compatible, significant, and relevant to the resource at various scales. It is also necessary to understand the scale in which other conservation partners are operating within the larger regional planning area, local planning area, State, or bird conservation region. Refuges are often unique within cooperative regional conservation planning efforts because they are part of the larger Refuge System; they are one of the few conservation entities that need to consider their role at the continental scale. While it may seem counterintuitive, incorporating large-scale perspectives can assist in narrowing the focus in deciding management priorities within certain management units (Knopf 1994). In fact, a refuge's highest priority may be decided based on its contribution to priority resources at the continental scale.

2.1) Regional Plan Ranking

Various Service programs and partner agencies and organizations have developed regional "prioritization rankings" for various resources of concern. These represent the best science and professional judgment of the larger conservation community. We used this as a "first filter" to identify priority resources of concern. Table B.2 below identifies the lists and rankings that were used.

Table B.2. Regional Plans and Lists and their Respective Rankings.

Regional Plans and Lists	Rankings selected for Priority Species
Federal List of Threatened and Endangered Species	Threatened, endangered, and candidate species supported by refuge habitats
U.S. Fish and Wildlife Service - Birds of Conservation Concern (BCC)	All species supported by refuge habitats on the BCC list for BCR 30
U.S. Fish and Wildlife Service - Birds of Management Concern	All species supported by refuge habitats
BCR 30 Priority Species List	Species supported by refuge habitats with priorities of "highest high" or "high"
PIF 9 Priority Species List	Species supported by refuge habitat with priorities of 1A, 2A, 2B, or 2C
U.S. Shorebird Conservation Plan–Atlantic Flyway	All species supported by refuge habitats that also have BCR 30 priorities of either "highest high" or "high"
North American Waterbird Conservation Plan	All species supported by refuge habitats that also have BCR 30 priorities of either "highest high" or "high"
North American Waterfowl Management Plan	All species supported by refuge habitats that also have BCR 30 priorities of either "highest high" or "high"
U.S. Fish and Wildlife Service–List of Fish Trust Species	Declining species in Gulf of Maine ecoregion supported by refuge habitats
Priority Marine Mammals	All species supported by refuge habitats (none identified)
NHB Rare Species Distribution and Occurrence Maps	All threatened and endangered plants and invertebrates, and regionally rare birds supported by refuge habitats
New Hampshire Comprehensive Wildlife Conservation Plan Priorities	All non-bird species with Species Action Plan supported by refuge habitats
NHB Natural Communities of New Hampshire	Exemplary or underrepresented communities in the State (G1-3; S1-2)

Supporting Discussion:

Partners In Flight (PIF) and Bird Conservation Regions (BCRs) have incorporated both the regional and continental scales into their species ranks, providing a starting point for selecting priority bird species for a refuge. PIF (landbirds) and BCR (all birds) plans use Breeding Bird Survey and Breeding Bird Atlas data to identify species that are of high conservation priority for defined geographic regions. The priorities are based on long-term declines and threats to long-term viability, as well as the ability of conservation actions in a particular geographic region to contribute to long-term population stability based on relative abundance of the species population.

The PIF/BCR tiering helps prioritize landbird conservation efforts at different scales. The role of refuges is to address the habitats of species of high continental concern and species that have a high proportion of their population in a particular BCR. This will allow an individual refuge to have the greatest impact nationally and regionally, while contributing to BCR goals. By first looking at the habitats of selected species, we maximize the efforts of the Refuge System by managing for the habitats with the highest ranking species, which typically represent the habitats unique to that portion of the continent.

For non-bird species, where regional and national scale prioritizations are not available, we relied on New Hampshire Natural Heritage and Piscataqua Regional Estuaries Partnership priorities and reports.

2.2) Review of Baseline Wildlife Surveys

We did a comprehensive review of baseline wildlife surveys conducted to date to assist with determining species presence and abundance on the refuge. Additional surveys were conducted during the CCP process as budget and staffing allowed. We selected species prioritized in regional plans and were consistently found on the refuge in good abundance for the Priority List. Rare species that occur in small numbers, had historical distribution on the refuge, or had potential for reintroduction and recolonization also were selected for the Priority List. The list of surveys and their results are described in detail in chapter 3.

2.3) Reviewed Habitat Requirements and Current Distribution

For species that were not already documented on the refuge through survey data, we reviewed species habitat requirements and current species distribution to determine the likelihood of the species to be on the refuge and the potential for the refuge to contribute significantly to the State, regional, or national population. Our main sources included Birds of North American Online (Cornell University) and species profiles from the New Hampshire State Wildlife Action Plan.

2.4) Gather Expert Opinion

Partner Meeting

We met with various State and Federal agencies to discuss Great Bay Refuge's greatest contribution to the Great Bay Estuary region, the State, and the Northeast.

Site Visit with Community Ecologist

In 1999, NHB conducted sites visits to develop habitat community maps for the Great Bay Refuge. Dan Sperduto, author of the "Natural Communities of New Hampshire" did the initial mapping. Afterwards, he revisited the refuge to work with the refuge biologist to identify exemplary communities and site capacities of altered habitats.

Consultation with Other Experts

For certain species with little to no survey data, such as bats, amphibians, and reptile use on refuge, we consulted with local and regional experts, including Dave Yates from Biodiversity Research Institute and Kim Babbitt from University of New Hampshire.

3) Select Focal Species by Refuge Habitat Types

3.1) Associating Priority Resources of Concern to Refuge Habitat Types

While vegetative communities are mainly dictated by soils, hydrology, and plant communities, many wildlife species use more than one vegetative community. In fact, the juxtaposition of different vegetative communities in the landscape provides the various habitat requirements for specific species. For example, many amphibians and reptiles breed in seasonal wetlands, called vernal pools, but spend the majority of their life cycle in adjacent upland habitat. Table 3.9 in chapter 3 of the CCP sorts the mapped vegetative communities into broad habitat categories that are more meaningful from a wildlife management standpoint. All goals, objectives, and strategies in the CCP are developed for these broader habitat categories. We then assigned the priority resources of concern to these habitat categories. As most refuge management activities are focused on habitat manipulation or restoration, this association ties the species priorities into tangible management objectives.

3.2) Incorporating Biological Integrity, Diversity, and Environmental Health Elements

In selecting priority resources of concern and focal species, we used the biological integrity, diversity, and environmental health elements table (table B.1) to identify the refuge's capability and greatest contribution. Filters used include site capabilities, limiting factors, response to management or restoration, as well as, ability to maintain or restore aspects of ecological or ecosystem processes within the refuge and surrounding landscape. A few examples of these filters are highlighted below.

Site Capability/Limiting Factors. Under current refuge management, the refuge would manage for many small grassland units. Baseline surveys indicate that most of these small grasslands do not provide benefits to priority grassland nesting birds. Additionally, soil maps and additional soil surveys confirm that the soils mainly support forested habitat (oak-hickory forest or maple/beech forests). The annual mowing of these numerous small tracts also increases management burden. During the CCP process, we reevaluated grassland management and proposed to focus on maintaining and restoring two to three large grassland units, with dry and sandy soils that would be more appropriate to maintain as a grassland. These areas also had historic records of upland sandpipers, a priority species for the State.

Response to Management or Restoration. Although currently not present at Great Bay Refuge, we are proposing to restore and manage habitat for New England cottontail. This species is a candidate species for the Federal List of Threatened and Endangered Species. It is currently persisting in small (less than 10 to 20 acres), fragmented, shrub habitats in a fraction of its historical range. There is a significant extant population just across Great Bay that the refuge is working with partners to protect. One of the major threats to this species is that lack of habitat management on conserved lands to provide the early successional (dense shrub) habitat it requires. Refuges have the expertise, equipment, and a mandate to manage for this species, thus providing a unique opportunity to expand the existing population and restore new populations. Unlike other habitats (like grassland or forest) which require larger contiguous tracts, managing for 10 to 20 acre shrub habitat would significantly contribute to the recovery of this species.

Restoring Ecological Integrity and Ecosystem Process. As described in chapter 3, New England has the longest land use history in the United States. As such, it's difficult to find areas where natural ecological processes are fully intact. However, one can often find areas where these processes are mostly intact, such as the oak-hickory community (including forested and shrub wetlands) on Great Bay Refuge. This plan proposes small changes to restore ecological integrity, such as minimizing edge habitat from trails and forest openings, and restoring hydrological flow in the lower Peverly Book.

3.3) Selecting Focal Resources

For each of these broad habitat categories types, we then selected focal resources for management and monitoring purposes. Focal resources are highly associated with conditions that represent the needs of larger groups of species or communities that have similar requirements (e.g., habitats, ecological and/or ecosystem processes) and respond to management similarly. When wildlife are selected as focal resources, they may be selected because they reflect the distribution and abundance of species with similar requirements (focal species), their protection covers a wide range of co-existing species in the same habitat (umbrella species), a species whose status provides information on the overall condition of the ecosystem and of other species in that ecosystem (indicator species), or species that have an effect on many other species in an ecosystem disproportionate to their abundance or biomass (keystone species). By managing for focal resources, important components of functional, healthy ecosystems will be addressed. Also, through our management for focal resources, we hope to conserve our priority species and habitats. The following table identifies refuge habitat types and associated focal species.

Table B.3. Priority Habitat Types and Their Associated Focal Species for Great Bay Refuge.

Priority Habitat Types	Associated Focal Species
Freshwater impoundments	Marsh wren, migrating and wintering waterfowl, nesting marshbirds, alewife, blueback herring, American eel, large bur-reed
Intertidal Estuarine*	Eelgrass beds, oysters, alewife, blueback herring , American eel
Salt marsh and rocky shoreline	Wintering black duck, wintering bald eagle, foraging marsh and wading birds, migratory shorebirds, salt marsh sparrow, seaside mallow, American eel
Forested and scrub-shrub wetlands and vernal pools	Willow flycatcher, wood thrush, vernal pool obligate amphibians, foraging woodcock, and native plant communities

Priority Habitat Types	Associated Focal Species
Oak-hickory forest	Wood thrush, scarlet tanager, Baltimore oriole, solitary tree bats
Shrubland	Eastern towhee, prairie warbler, blue-winged warbler, American woodcock, black racer, New England cottontail
Grassland	Upland sandpiper, American woodcock, Eastern meadowlark, New England blazing star

* *This habitat type does not occur on the refuge, but is an important priority habitat in the Great Bay Estuary.*

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